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**GUAM AGRICULTURAL EXPERIMENT STATION
ISLAND OF GUAM**

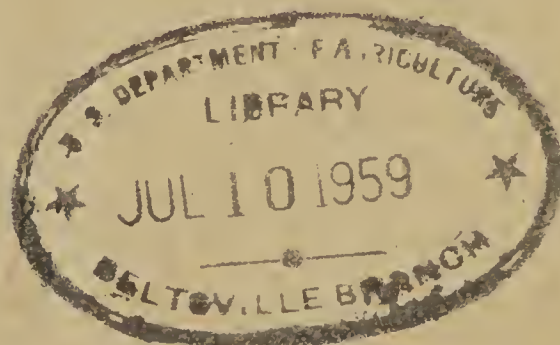
Under the supervision of the
UNITED STATES DEPARTMENT OF AGRICULTURE

**REPORT OF THE
GUAM AGRICULTURAL EXPERIMENT
STATION**

1929



Issued February, 1931



GUAM AGRICULTURAL EXPERIMENT STATION, ISLAND OF GUAM

[Under the supervision of the Office of Experiment Stations, United States Department
of Agriculture]

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GUAM AGRICULTURAL EXPERIMENT STATION
ISLAND OF GUAM, U. S. A.

Under the supervision of the
UNITED STATES DEPARTMENT OF AGRICULTURE

Washington, D. C.



February, 1931

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EXPERIMENT STATION, 1929

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REPORT OF THE DIRECTOR

By C. W. EDWARDS

The main experimental activities of the station during the fiscal year covered by this report were a continuation of those begun in earlier years. The station is the only agency on the island carrying on agricultural investigations, and in the absence of an extension force much of the time of certain members of the staff is consumed in visiting farms in response to requests of individual farmers for advice on livestock and plant diseases, and on other agricultural matters. As was the case in previous years, the station cooperated with the department of public instruction in giving a practical short course on agricultural subjects at the station for boys of the graded schools, and a series of talks before the normal-school classes of young men.

Selected graduates of the graded schools were employed as apprentice laborers at the station, and members of the staff served as judges of the garden and livestock exhibits at the school fair. The station further cooperated with the Government insular departments by furnishing to the island forester and the island Government assistant extension agent plant material for distribution, and also by giving advice to these officials concerning their work. Many requests were complied with during the year for plans and plant material for use in beautifying the grounds of local private residences and Government buildings.

In animal husbandry, effort was continued to establish an improved station herd by selective breeding, improve the livestock of the island by the introduction of new blood, determine the suitability of certain grain mixtures for grade milk cows and the value of introduced grasses for forage, and investigate the so-called loin disease of cattle.

Breeding and feeding tests were continued with chickens, and anthelmintics were tried to determine their comparative efficacy for the intestinal parasites affecting them. The breeding work has now reached a stage where expansion is necessary if satisfactory results are to be expected. The whole equipment for poultry should be enlarged and improved, including storage and feed facilities.

The assistant in poultry husbandry, working in cooperation with the island Government assistant extension agent, made a number of visits to different parts of the island where "school meetings" with farmers were held. He also served as one of the poultry judges at the annual school fair, and gave a series of talks on poultry raising to the teachers of the normal-school classes.

The work in agronomy and horticulture included mainly palatability tests with forage grasses, cultural tests with lawngresses, variety tests with legumes, root crops, and vegetables, propagation experiments with the mango, the avocado, and the sapodilla, locally known as the chico, and the distribution of seeds and plant material. There are no private nurseries or seed firms on the island; hence the station devotes considerable time to the production of economic and ornamental plants to satisfy as far as possible the local demand for them.

The local supply of hardwood, principally ipil (*Intsia bijuga*) and daok (*Calophyllum inophyllum*), is rapidly being depleted. A comprehensive reforestation program should be begun, but neither the island Government nor the station is financially able to undertake the work on a large scale. The station is doing what it can to remedy the situation. Ipil, because of its extremely slow growth, is not suitable for reforestation purposes, and seed of various other kinds of hardwood, including mainly teak, mahogany, and narra, have been introduced to test their adaptability to local conditions. The teak has made surprisingly good growth so far. Seed of narra is now available from the plantings at the station, and seed of teak and mahogany are being introduced each season. Some of the seed is turned over to the chief forester, the schools, and the island Government assistant extension agent for use, and the rest is grown by the station for the production of seedlings for distribution. A local regulation provides that suitable seedlings shall be planted on all areas from which hardwood timber is removed. The regulation does not, however, refer to any particular source for the supply of these seedlings. Acting on the suggestion of the station, the department of public instruction has provided propagating sheds in the various school districts where, in connection with the school-garden work, timber seedlings may be grown for distribution to ranchers living in the localities.

During the year a local corporation was formed for the purpose of growing and canning pineapples. To date 160,000 plants have been set out. The station is assisting in this work in every way possible because it is realized that a successful pineapple industry

would materially benefit the people of the island. At the outset the organization is growing the fruit for its cannery, but it is hoped that in time the native farmers will have become sufficiently interested in the industry to produce pineapples as an adjunct crop on their farms to supply all the fruit for the factory. Planting material for this project was obtained at the request of the station from Hawaii through the courtesy of J. M. Westgate, director of the Hawaii Agricultural Experiment Station, and certain other insular officials, including especially D. T. Fullaway, Territorial entomologist of Hawaii. The station further assisted in the undertaking by responding to requests for advice on the selection and preparation of land for pineapple growing and by furnishing data on the results obtained at the station with pineapples.

The work in entomology dealt chiefly with parasites of the European corn borer, the house and stable fly, internal parasites of poultry, the life histories of some of the more important insect pests in Guam; and studies of plant diseases.

CATTLE

FEEDING TEST

In the feeding test with grade milk cows, a local mixture consisting of 100 pounds of corn (white) and 80 pounds of coconut meal is being compared with an imported mixture made up of 100 pounds of corn (white), 50 pounds of oats, 25 pounds of wheat bran, and 25 pounds of cottonseed meal. The grain is fed coarsely ground. The cows are pastured on *Paspalum dilatatum* and when stabled at night are given green forage in addition to the grain. This year the test periods were of 25 days' duration. In every instance the first five days of each period was considered a preliminary interval, and the production for this time was excluded from the tabulation. Table 1 gives the results of this test.

TABLE 1.—Effect on milk yield of feeding a local and an imported grain mixture to cows¹

Cow No.	Date of calving	Test period	Total days in test	Grain mixture	Milk yield		Remarks
					Per mixture	Total	
193	Oct. 29	Dec. 2-Dec. 21 Jan. 21-Feb. 9 Mar. 12-Mar. 31 May 1-May 20 Dec. 27-Jan. 15 Feb. 15-Mar. 6 Apr. 6-Apr. 25 May 26-June 14	Number	No. 2, imported	Pounds		Difference of 100.53 pounds in favor of mixture No. 2, imported.
					342.37	295.25	
					260.07	1,115.69	
					218.00		
					316.08		
					272.44	1,015.16	
					236.64		
					190.00		
					391.66		
					353.14	1,393.21	
62	Nov. 11	Jan. 21-Feb. 9 Mar. 12-Mar. 31 May 1-May 20 Dec. 27-Jan. 15 Feb. 15-Mar. 6 Apr. 6-Apr. 25 May 26-June 14	Number	No. 2, imported	Pounds		Difference of 101.26 pounds in favor of mixture No. 2, imported
					337.31	314.10	
					370.79		
					340.00	1,291.95	
					324.89		
					259.27		
					340.82	970.91	
					327.26		
					302.83		
					329.88	892.91	
50	Dec. 14	Apr. 6-Apr. 25 May 26-June 14	Number	No. 1, local	Pounds		Difference of 78 pounds in favor of mixture No. 2, imported.
					306.53		
					256.50		

¹ In continuing the test, the cows were started on the imported (No. 2) mixture.

Table 1 shows a difference in milk yield of about 1 pound per head per day in favor of the imported mixture. In the tests of the preceding year the difference was in favor of the local mixture, although the amount was appreciable in only one instance. In these tests some allowance must be made for the natural decrease in milk production with the advancement of the lactation period. This factor gives the first mixture used some advantage over the second. The test was discontinued because a shipment of grain failed to arrive.

PALATABILITY TEST

A number of varieties of grasses including Para grass (*Panicum barbinode*), *Paspalum dilatatum*, Rhodes grass (*Chloris gayana*), Vasey grass (*Paspalum urvillei*), molasses grass (*Melinis minutiflora*), and guinea grass (*Panicum maximum*), were each grown on $\frac{1}{10}$ -acre plats in an effort to collect data regarding their palatability for cattle. Six months after the varieties were planted they ap-



FIGURE 1.—Calves in pasture test

peared to be uniform in succulence, and three calves were turned on the plats to pasture. (Fig. 1.) For the first few days only the Para and *Paspalum* grasses were eaten. The calves then crossed over to the last plat, opposite the field entrance, and began feeding upon the guinea grass. After one week of pasturing mostly on guinea grass they began to eat the Vasey grass, and about six days later the Rhodes grass. During the next 20 days the calves seemed to show an equal liking for the Para, *Paspalum*, Rhodes, and Vasey grasses. Although all these grasses were fairly well grazed, the molasses grass was eaten only sparingly. For the next 24 days grazing was heaviest on the guinea-grass plat and lightest on the

molasses-grass plat, while the other plats were grazed in proportionally equal amounts. Before they were placed on the test, the calves had been stall-fed Para and Paspalum grasses, a fact which may account for their early preference for them, but it does not alter their later behavior. The changes in preference for the different grasses were not due to close pasturing of any plat at the time.

MATAI TATI DISEASE

Often cattle that are pastured wholly on the savannas, or red-clay uplands, of the island have a depraved appetite, as is shown by their chewing with apparent relish on pieces of bone, coconut shell, wood, and rock. Some of the animals eventually show symptoms of an ailment which is designated by the Chamorros as "matai tati." The trouble is somewhat like the pica disease of cattle in the southern United States, but some of the symptoms are different. The readily apparent symptoms of matai tati are a swaying or unsteadiness of gait of the hind quarters, and arching of the back when the animal is at rest. The irregular gait is more apparent when the animal is going up or down hill than when walking on level ground. In some instances the trouble gradually becomes so pronounced that the affected animal shows inability to stand. A few years ago when this trouble appeared in the station herd and in the herd of the collaborator at Cotot, bone meal was fed with good results. Since that time no new cases have appeared. Two of the affected animals apparently entirely recovered, and the others improved. In another instance ground cascajo (local coral rock) was beneficial, but not so much so as the bone meal. The ailment is apparently caused by a deficiency of minerals, especially lime and phosphorus, in certain of the local savanna pastures.

REPORT OF THE ASSISTANT IN POULTRY HUSBANDRY

By F. B. LEON GUERRERO

FEEDS AND FEEDING

Toward the close of the year a feeding test was begun comparing the efficiency of home-grown and imported feeds for laying pullets. Mungo beans and coconut meal are among the locally grown feeds being used. The isolation of Guam from low-priced feed-producing centers makes it necessary for island poultry raisers to grow their own feed for poultry. Copra meal may be secured locally at a reasonable price and has been used by the station in combination with both imported and home-grown feeds. The mungo bean, a popular food locally, has also been used as a part protein supplement in scratch and mash mixtures for poultry.

CHICKEN POX

During the latter part of the year the station flock was again affected with chicken pox. Only small chicks were attacked, the older stock apparently being resistant to this particular outbreak. The use of benetol and creolin, especially the former, gave good results in the treatment of the disease.

USE OF ANTHELMINTICS FOR INTESTINAL PARASITES

Anthelmintic studies, as reported last year, were continued. The use of anthelmintics for intestinal parasites of chickens has been found necessary in maintaining the health of the station flock, particularly the purebred fowls. As new data are secured on the seasonal distribution of various parasites in Guam the practical application of the findings of the station will be easier to determine than is now the case.

The use of carbon tetrachloride in oil (1 part to 3 parts fresh coconut oil) again proved to be satisfactory for ascarids and was of considerable benefit against tapeworm. Kamala was more satisfactorily used against stomach worms but gave poor results for ascarids. Papaya seed had very little effect on tapeworms and ascarids and no effect on other parasites. Epsom salts solution (1 ounce to 1 gallon of water) when kept before the chickens for 25 hours or longer was beneficial in expelling esophageal worms. At the end of this period some stomach worms also were voided. A dosage of pure coconut oil was not effective against any of the parasites.

PUBLIC STOCK-IMPROVEMENT WORK

During the year the station distributed to local poultry raisers surplus breeding stock and 219 settings of eggs for hatching.

REPORT OF THE ASSISTANT IN AGRONOMY AND HORTICULTURE

By JOAQUIN GUERRERO

FORAGE CROPS

Tests with various introduced forages and grasses were continued. Some of the work has been in progress sufficiently long to permit drawing definite conclusions. It has been determined that Napier grass (*Pennisetum purpureum*) is adapted to the tillable soils of the island. Napier grass makes a good growth even on certain of the sandy beaches where few, if any, other crops except coconuts are produced. Guatemala grass (*Tripsacum laxum*) is adapted to the principal soil types but has not been tested as extensively as Napier grass. Japanese cane (*Saccharum sinense*) has not been grown satisfactorily except on the lowland clays where the drainage is at least fairly good. *Pennisetum setosum* shows as wide a range of adaptability as Napier grass, but, unlike the latter, it is a heavy producer of viable seed. When a planting is allowed to ripen it is rapidly spread by the wind. Merker grass (*P. merkerii*) is adapted to both the lowland and the upland clay soils.

PALATABILITY AND CULTURAL TESTS

In cooperation with the animal husbandry division, plantings of guinea grass (*Panicum maximum*), molasses grass (*Melinis minutiflora*), Vasey grass (*Paspalum urvillei*), *P. dilatatum*, Rhodes grass (*Chloris gayana*), and Para grass (*Panicum barbinode*) were made August 17, 1928, on a mediumly heavy, well-drained clay lowland.

Each variety plat was approximately one-tenth acre in extent. The Para and the Paspalum made the most rapid growth, and the molasses grass the slowest. The two former varieties required no cultivation to suppress weed growth before entirely covering the ground, whereas each of the other varieties had to be given two cultivations before they reached this stage.

ADAPTABILITY TESTS

Napier grass (*Pennisetum purpureum*), Japanese cane (*Saccharum sinense*), Guatemala grass (*Tripsacum laxum*), *Pennisetum setosum*, guinea grass, molasses grass, Jaraguá grass (*Hyparrhenia rufa*), Para grass, Rhodes grass, Vasey grass, and *Paspalum dilatatum* were planted at the Barrigada farm September 25, 1928. (Fig.



FIGURE 2.—Forage test at Barrigada

2.) The soil of the area under test is similar to that of the greater part of the north-central part of the island. All the varieties except the Japanese cane made satisfactory initial growth. To date (June 30, 1929) the plantings have produced two cuttings—one January 21 and the other May 21. In both cuttings Napier grass gave the highest yield, followed by Para grass and guinea grass. In a planting of Japanese cane, Napier grass, Guatemala grass, Merker grass, and *Pennisetum setosum*, made November 8, 1924, on a rocky limestone hillside, Napier grass continues to produce the highest yield, and Japanese cane the lowest. A planting of Napier grass made by a local rancher shows its hardiness and adaptability to island conditions. The crop was planted during the period of light rains and on an area of sandy beach a short distance above the high-tide line. (Fig. 3.) Considering the season and the location it is thought the planting made remarkably good growth. To date the planting has

produced five cuttings, the last of which yielded at the rate of 12,215.7 pounds of green forage per acre.



FIGURE 3.—Napier grass planted on beach near Asan

LAWNGRASSES

Many requests are being received for information regarding suitable lawngrasses for Guam and methods of propagating them. In an attempt to find kinds that are better suited to local conditions than are the species generally used, the station introduced for trial samples of seed of carpet grass (*Axonopus compressus*), centipede grass (*Eremochloa ophiuroides*), and Japanese lawngrass (*Osterdamia japonica*). These grasses have not been grown under lawn conditions long enough to permit drawing definite conclusions, but the preliminary trials furnish some interesting data on behavior. On the lowlands centipede grass made the best growth, covering the ground satisfactorily, followed by carpet grass. The latter, however, is rather coarse and appears to be less suitable than the others for lawn purposes. A planting of carpet grass, made about three years ago on a thin, upland clay of poor fertility, although not cut or given any other attention, was killed by native grasses and other growth. In a planting at the Barrigada farm on soil which is similar to that of the greater part of the northern half of the island, carpet grass nine months after date of planting made the best growth, Japanese lawngrass made the next best, while centipede grass made a very poor showing. In a planting on a clay loam soil of fairly good texture which for many years had been devoted to *Paspalum*, carpet grass, centipede grass, and Japanese lawngrass made good growth. Nine months after date of planting the centipede grass covered the ground more effectively than the other grasses tested, followed by the carpet grass.

FIBER PLANTS

Henequen, maguey, and sisal plantings, on a very rocky hillside, have grown well. The henequen plants were set out in 1925, and the maguey plants about a year later. Both plantings are ready for the first harvest. The sisal was set out later than the other fiber plants.

LEGUMES

COWPEA VARIETY TEST

Eleven varieties of cowpeas were under test. The planting was made May 4, 1928, and harvested August 24, 1928. Conch again produced the highest grain yield of the varieties, and S. P. I. No. 46373 and S. P. I. No. 46175 gave the largest forage yield. White Queen, Brabham, Groit, Victor, and Black failed to yield grain, the pods rotting before they were ready for picking.

COVER-CROP EFFICIENCY TEST

In continuation of this project, one test with the Black Mauritius and the Alabama varieties of velvetbeans and the Hawaiian hybrid cowpea was completed during the year. The Black Mauritius velvetbean kept down weed and other growth for 208 days, the Alabama velvetbean for 119 days, and the cowpeas for 57 days. Plantings of seguidilla (*Botor tetragonoloba*), *Cracca villosa hirta*, and kalomu (*Calopogonium mucunoides*) were made toward the close of the year. The seed of the latter was recently introduced for trial from the Philippines through courtesy of P. J. Wester of the Philippine Bureau of Agriculture.

ROOT CROPS

SWEETPOTATOES (IPOMOEA BATATAS)

Work with sweetpotatoes was repeated. The planting was made October 24, 1928, at the Barrigada farm where the soil is considered to be well adapted for root crops. Harvesting was done April 1, 1929. The stand was considerably damaged by deer. The introduced varieties gave the following acre basis yields: Hawaiian No. 1, 11,192 pounds; Hawaiian No. 2, 8,468 pounds; Hawaiian No. 3, 6,452 pounds; Hawaiian No. 4, 10,648 pounds; Hawaiian No. 5, 9,680 pounds; Yellow Jersey, 9,680 pounds; Nancy Hall, 6,655 pounds; and Porto Rico, 8,167 pounds. The native varieties gave the following acre basis yields: Yap, 8,470 pounds; Patas Ngaña, 7,865 pounds; and Dago, 4,840 pounds.

YAMS (DIOSCOREA SPP.)

The yam planting of February 21, 1928, was harvested December 7, 1928. In this test the trellised plat gave a much higher yield than the untrellised plat. The acre basis yields were as follows: *D. latifolia*, trellised, 8,712 pounds; nontrellised, nothing; *D. alata*, trellised, 9,940 pounds; nontrellised, 4,690 pounds; Dagon Agaga, trellised, 14,200 pounds; nontrellised, 7,440 pounds; Dagon Apaca, trellised, 10,792 pounds; nontrellised, 8,946 pounds; Dagon Jaya, trel-

lised, 4,530 pounds; nontrellised, 1,813 pounds; Dagon Sumay, trellised, 6,923 pounds; nontrellised, 4,214 pounds; Nika, trellised, 9,380 pounds; nontrellised, 5,720 pounds; and Gado, trellised, 7,100 pounds; nontrellised, nothing.

The crop matured during the rainy season, and at harvest time the varieties Gado and *D. latifolia* were found to have rotted on the nontrellised plats.

FRUIT INVESTIGATIONS

SAPODILLA (ACHRAS ZAPOTA)

The sapodilla, called chico in Guam, which is commonly found growing in the Philippines, apparently was not introduced into Guam during the pre-American history of the island. A few trees of bearing age of comparatively recent introduction are to be found growing locally, but except in one instance they are barren, or at least are very shy bearers; hence they are not a suitable source of propagating material. The station has made many unsuccessful attempts to establish this fruit locally by introducing the seed for trial. Within recent years introduced marcottaged cuttings have been successfully grown. During the early part of the fiscal year a prolific bearing sapodilla was found growing in the town of Sumay. Efforts are being made to obtain as many marcottaged plants as possible from this tree. To date (June 30, 1929) 14 young trees from this source have been distributed, and 7 have been set out in the station orchard.

PINEAPPLE

The organization during the year of a local corporation for the purpose of growing and canning pineapples is an important event in the agricultural history of the island. Approximately 30 acres have been planted with pineapples, and most of them are making satisfactory growth.

CITRUS

Scaly bark and gummosis of citrus are present in most parts of the island. In some instances a combination of the characteristics of both scaly bark and gummosis are present. Many citrus trees have already succumbed to their attack. In an attempt to remedy the situation, the station has tested a number of different treatments. Apparently the treatment giving the most benefit is that of scraping the infected parts of the tree, disinfecting the wound with bichloride of mercury (1:500 in a 25 per cent aqueous solution of ethyl alcohol), and applying a Bordeaux mixture paste.

The tineid leaf miner (*Phyllocnistis citrella*) has been troublesome to citrus seedlings in the nursery. A spraying test was begun April 9, 1929, comparing the value for leaf miner control of lead arsenate, black leaf 40, oil emulsion, lime-sulphur, calcium arsenate, and derrisine, a commercial insecticide combined with lime-sulphur, and a Japanese proprietary preparation. The different kinds of treatments were applied once weekly for a period of six weeks. The black leaf 40 gave the best results, followed by the oil emulsion, and the lead arsenate made the poorest showing. (Fig. 4.)

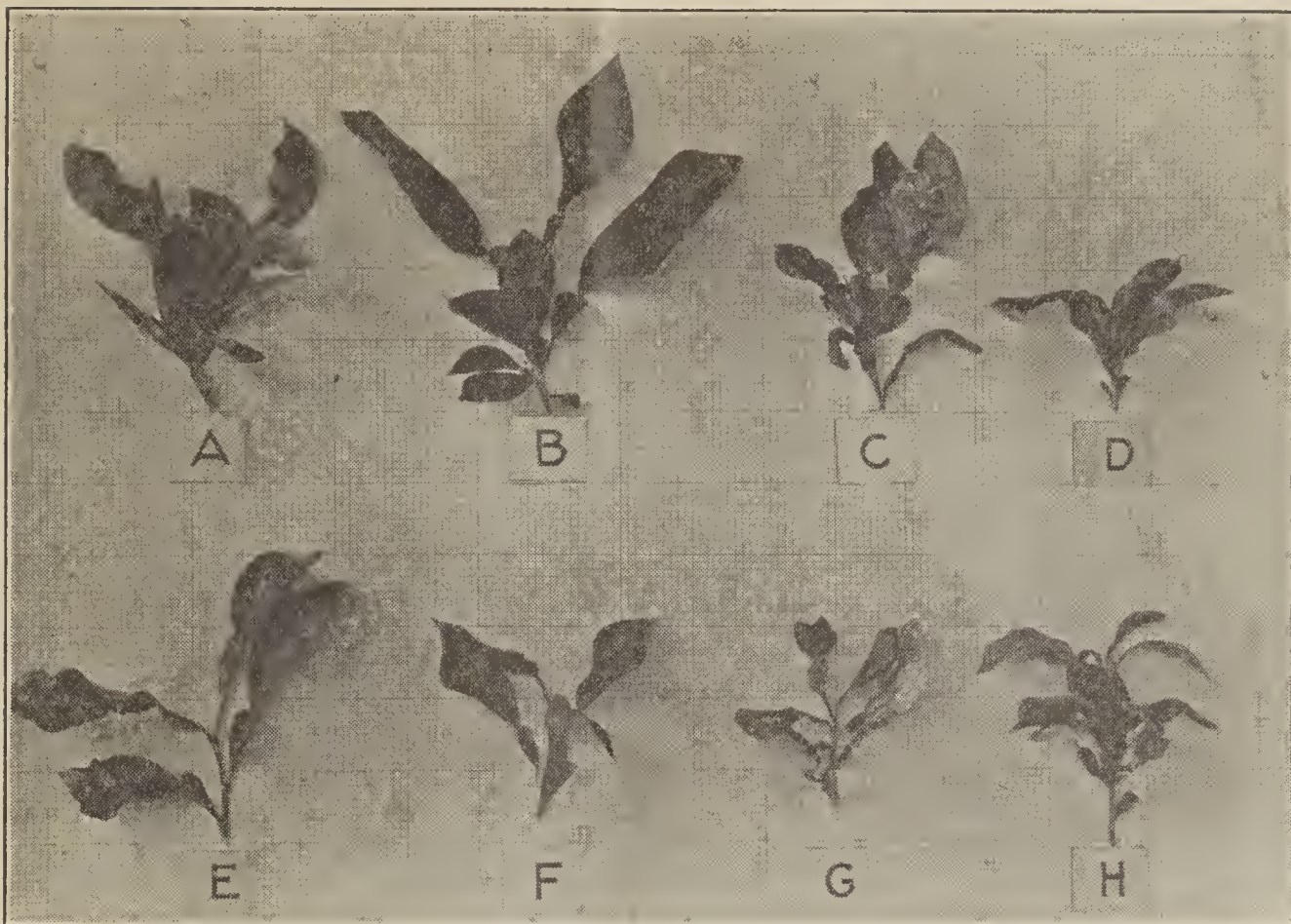


FIGURE 4.—Tineid leaf miner spray test with citrus: Effect of A, lead arsenate; B, black leaf 40; C, oil emulsion; D, lime-sulphur; E, Japanese proprietary insecticide; F, calcium arsenate; G, derrisine and lime-sulphur; H, no treatment (check)

AVOCADO AND MANGO

In continuation of the work of determining the best methods of asexually propagating avocado and mango trees and of producing grafted trees for distribution, several hundred avocado and mango seedlings were successfully grafted during the year and are now ready for distribution, and 2,000 seedlings were grown for further operations. Of the propagation methods employed during the year the side-graft method, together with the practice of leaving the top of the stock intact until after proper union has taken place, gave the most satisfactory results.

FORESTRY

The hardwoods of the island are mainly iphil (*Intsia bijuga*) and daok (*Calophyllum inophyllum*), and the less durable species, which are suitable for certain building purposes, are yoga (*Eleocarpus joga*), and the varieties of *Artocarpus communis*, especially dog-dog. The supply of these timbers, particularly the hardwoods, is rapidly becoming exhausted. The station is assisting in the work of reforestation as much as possible. Local seedling material is grown for distribution to the farmers, through the agency of the schools and the island forester, and seeds of various hardwoods are being introduced and the seedlings distributed to test their adaptability to local conditions. Of the imported hardwoods, teak (*Tectona grandis*), narra (*Pterocarpus indicus*), and mahogany (*Swietenia mahagoni*) appear to be well suited to Guam conditions. Teak particularly has made



FIGURE 5.—Teak planted on lowland

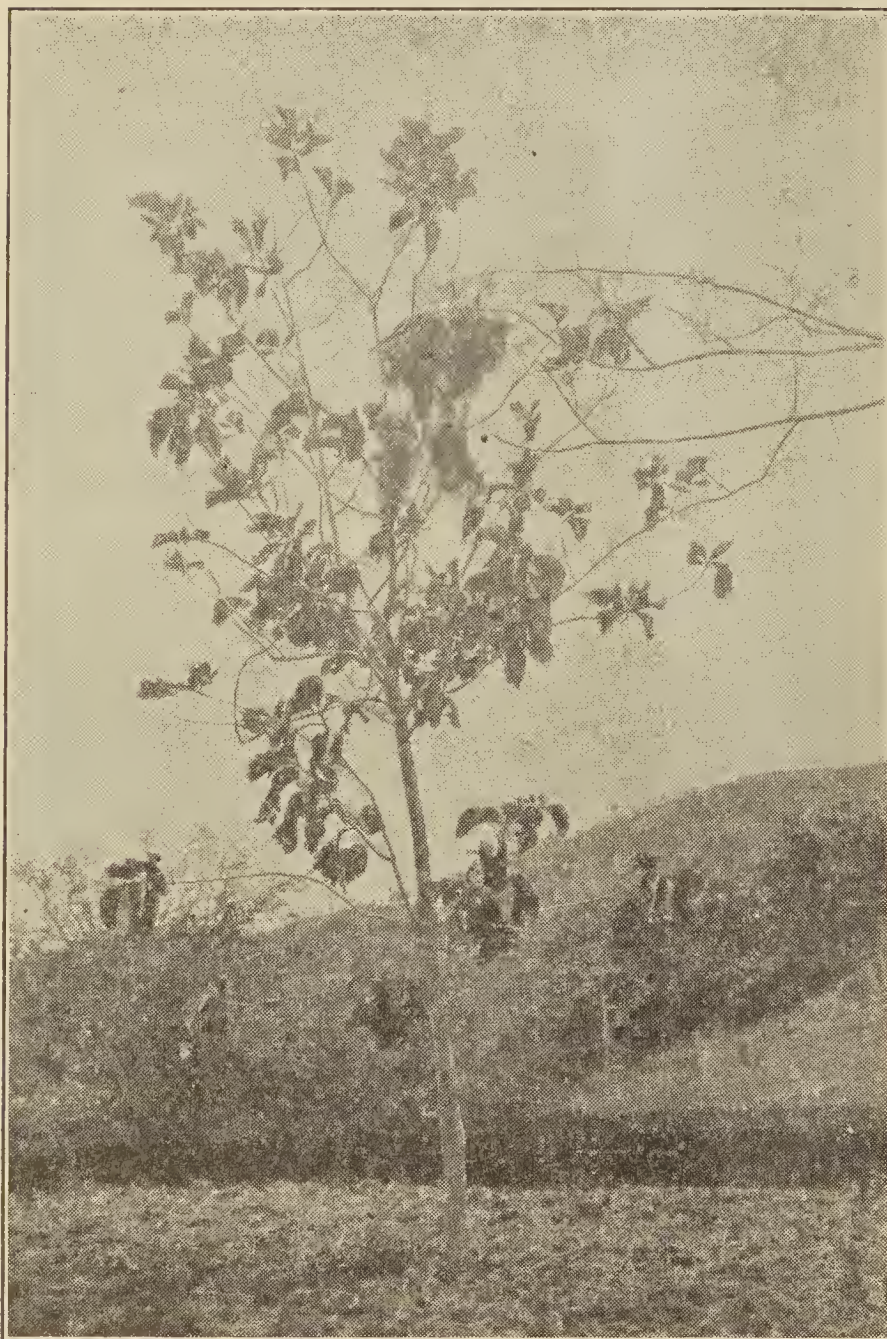


FIGURE 6.—Teak planted on highland

a good showing. (Figs. 5 and 6.) This valuable species appears to be adapted to most of the tillable soils of the island. Grown on a small area of reclaimed river-bottom land, the trees average 14 feet high at 23 months after date of planting. Narra is apparently suited for planting on the heavy clay lowlands where drainage is fairly good, and on some of the soils of the northern part of the island. Mahogany has grown very well on river-bottom land, and fairly well on a mediumly heavy clay loam. (Fig. 7.) Seedlings planted two years ago on a rocky limestone hillside are making good growth.

To determine the possibility of growing certain economic trees on the otherwise waste savanna lands, seedlings of cashew, commonly known in Guam as casoy (*Anacardium occidentale*), talisay



FIGURE 7.—Mahogany planted on lowland

(*Terminalia catappa*), albizzia (*Albizzia lebbek*), mahogany, gago (*Casuarina equisetifolia*), pili-nut tree (*Canarium ovatum*), *Aleurites trisperma*, and algaroba (*Prosopis chilensis*) were set out during the rainy season on a typical red clay upland area of very poor fertility.

With the exception of the pili-nut tree and the mahogany, a number of seedlings of each of the species made promising growth. Another planting of mahogany made a very good showing on a savanna area where the soil is of a light clayey nature, underlain by limestone. For some years this area was covered with a heavy growth of *Leucaena glauca*, locally known as tañgantañgan. The station has endeavored from time to time to determine the best methods of improving the soil of the unproductive savanna lands. Tañgantañgan is adapted to certain areas and offers a means to this end. During the year several methods of planting this leguminous shrub were tried. A satisfactory stand was obtained both by dibbling and by broadcasting the seeds. The use of stems of less than an inch in diameter for propagation purposes resulted in a poor stand.

GARDEN-VEGETABLE DEMONSTRATIONS

EFFECT OF COCONUT MEAL ON YIELD OF BEANS

In continuation of the work to determine the effect of coconut meal on the yield of beans, six different plantings of the Kentucky Wonder variety were included in this year's tests. The meal was applied at the rate of 1,000 pounds per acre and resulted in an increased yield in each instance. The acre basis yields were as follows: From fertilized plats, 5,510, 3,728, 3,154, 2,645, 2,294, and 2,257 pounds, and from unfertilized plats, 4,814, 2,983, 2,627, 1,998, 1,628, and 1,147 pounds, respectively, per plat.

BEAN VARIETY TEST

A test was made with 15 bush and 12 pole varieties of beans to determine those best adapted to local conditions. The planting was made May 18, 1929, and harvested in July and August. Of the bush varieties, only Jackson Wonder and Stringless Green Pod produced satisfactorily. These yielded at the rate of 11,875 and 900 pounds, respectively, per acre. The pole beans gave the following acre basis yields: New McCaslan, 1,625 pounds; Genuine Cornfield, 3,550 pounds; White Cornfield, 3,440 pounds; Georgian, 4,800 pounds; Yopps, 4,000 pounds; small white Lima or butter bean, 4,575 pounds; large white Lima, 175 pounds; Florida butter, 2,500 pounds; Kentucky Wonder Wax, 4,475 pounds; and Kentucky Wonder, 4,356.25 pounds.

CABBAGE VARIETY TEST

Eleven varieties of cabbage were planted November 10, 1928, and harvested in March and in April, 1929. Of these, the variety used of Long Island Wakefield, Genuine Surehead, Copenhagen Market, and Centennial Late Flat Dutch failed to head. The others gave the following acre basis yields: All Seasons, 2,850 heads, 5,795 pounds; Early Winningstadt, 427 heads, 987 pounds; Golden Acre, a strain of Copenhagen Market, 8,140 heads, 15,414 pounds; Sure Crop, 11,340 heads, 19,792 pounds; Early Blood Red Erfurt, 4,239 heads, 5,348 pounds; Perfection Drumhead Savoy, 1,572 heads, 1,310 pounds; and Danish Ballhead, 616 heads, 1,020 pounds. The heads were of good quality in each instance except for Perfection Drum-

head Savoy. The latter produced heads which were not as compact as might be desired.

TOMATOES

Work with tomatoes was confined to variety and selective breeding tests. In the variety tests conducted during the year, Marglobe gave the best results, the yield being above that of any other intro-



FIGURE 8.—Marglobe tomatoes

duced variety. (Fig. 8.) In the selective breeding work, Cristobal made little progress. One crop of the fourth-generation hybrids resulting from crossing Greater Baltimore with the native tomato was harvested. The crosses apparently show no improvement in size and quality over those of the first generation.

SEED AND PLANT DISTRIBUTION

During the year there was a change of policy in disposing of the vegetable seeds purchased by the island Government from the United States for sale to the public at cost. For several years the station has distributed these seeds. The work of distribution was transferred to the department of education. The arrangement does not affect the distribution of the introductions and productions of the station. The general distribution during the year included 338 packets of vegetable seeds, 44 Isabella grape cuttings, 578 papaya plants, 35 pepper plants, 142 eggplants, 150 tomato plants, 584 lum-bang plants, 20 cashew (casoy) plants, 57 algaroba plants, 55 pili-nut plants, 195 baguilumbang plants, 200 tobacco plants, 172 pine-apple plants, 127 mahogany plants, 3 Macadamia-nut plants, 4 rose-apple plants, 2 guava plants, 2 pejibaye plants, 20 lemae plants, 3 ciruela plants, 8 mabolo plants, 159 tangerine plants, 949 orange plants, 8 mountain-apple plants, 17 mangosteen plants, 2 pistache plants, 5 galo plants, 3 lanzon plants, 12 banana plants, 1 litchi plant, 22 chico marcottaged plants, 8 kei-apple (Aberia) plants, 119 seedling and 15 grafted avocado plants, 3 grafted mango plants, 138 lemon plants, 45 teak seedlings and 1 caban of teak seeds, 1 sack of sweetpotato cuttings, 492 miscellaneous palms, 1,671 ornamental plants, 3 pounds of sorghums, 4 pounds of rice, 15 pounds of legume seeds, 1 pound of adlay, and 4 sacks of Paspalum roots.

REPORT OF THE ENTOMOLOGIST

By S. R. VANDENBERG

EUROPEAN CORN-BORER PARASITES

As was reported last year in the breeding work with the European corn-borer parasite (*Exeristes roborator*), mortality in the larval and pupal stages is rather high, because of the rotting of the corn-borer larvae used as food. Despite all precautions mortality continues to be high, and during short periods of hot weather when the temperature in the insectary registers about 96° F., fully 75 per cent of the feeding parasitic larvae die. One or two days of such hot weather will affect practically a week's production. Notwithstanding this trouble, many parasites have been reared to maturity and liberated in the local cornfields. The outlook for its becoming established in the fields is not very promising at present, for out of the thousands of these parasites that have been liberated only one has been recovered and this was in the form of a pupa which when brought to the insectary later emerged as a medium-sized and normal female.

HOUSE-FLY AND STABLE-FLY PARASITES

Methods for rearing parasites (*Spalangia* sp.) of the house fly and the stable fly were improved, and losses from the fungus that attacks the fly pupae were practically eliminated. Moss and partly decomposed pine shavings were used as a medium for the fly pupae instead of the sand, earth, and leaf mold formerly used and were found to prevent the growth of fungus. The nature of the texture of the shavings and the moss enables *Spalangia* to enter the material readily in search of fly pupae for parasitization. Pine shavings were more satisfactorily used than moss because they permitted the maintenance of optimum moisture conditions in the breeding jars and did not become water-logged. Liberations of the parasites were made throughout the year in practically every district, but the natural spread is evidently very slow. The parasites will hardly cover the whole island for some years because their method of flight is somewhat in the nature of a short hop, such as is characteristic of minute hymenopterous parasites, and also because they take refuge in sheltered places when the wind is high. An occasional check of parasitization around the station barns and manure pits indicates that *Spalangia* are increasing under natural conditions.

MISCELLANEOUS NOTES

The reappearance of the Vedula (*Novius cardinalis*) in the station orchard coincidental with the reappearance of the cottony cushion scale (*Icerya purchasi*) was noted with satisfaction. Over two years ago this beetle was introduced to combat a heavy infestation of the scale. After subduing the scale the Vedula disappeared until March of this year. It was then found working on an infestation on three lemon trees. After completely subduing its host, the Vedula again disappeared.

The tachinid fly (*Ceromasia sphenophori*), which was reported last year as successfully controlling the sugarcane borer at Togcha, has apparently died out. Examination of over 100 larvae and pupae of this borer collected from the same vicinity did not reveal the presence of a single parasite. Neglect of the field probably accounts for the situation. While breeding operations were under way the field was kept free from trash, weeds, and grass, but later was invaded by cattle and neglected. The parasite does not work in such fields, probably because the tangled masses containing the food are too dense, some of them being 2 to 3 feet deep.

Life-history studies were continued with the corn borer (*Pyrausta nubilalis*), the cottony cushion scale (*Icerya purchasi*), and the black kapok scale (*Saisettia nigra*). Further studies of the ability of the coconut scale (*Aspidiotus destructor*) to reproduce asexually were made. It is thought this scale can reproduce for a number of generations independently of the male. This opinion, however, has yet to be supported definitely. The male was kept excluded as far as it was possible with the equipment available at the station and under the conditions prevailing in Guam.

During the past dry season some papaya fruits at the station were severely attacked by a fungus disease not formerly observed in Guam. A study of the disease showed it to be caused by *Penicillium* sp. Artificial inoculation experiments were successful not only on susceptible but also on naturally resistant varieties. It is concluded, therefore, that the fungus, although normally wind borne, may also be mechanically carried by insects, birds, and rats, and that through injuries by these agencies otherwise resistant fruit may become inoculated. A check of the artificial inoculation experiment by cutting or scarifying the rind of the fruit with a sterile knife showed negative results. Degrees of natural resistance were noted among the different plants under test. Plants, the fruits of which were similar in type to the small, round, native papaya, proved to be the most susceptible to attack by the fungus, whereas the large, long-fruited Hawaiian variety apparently was resistant. The fairly large fruit of one apparently resistant tree was picked when beginning to color and kept for observation. Within 24 hours this fruit became covered with small, sunken, water-soaked areas of a slightly darker green than the normal rind color. A day or two later the fruit was completely discolored and the sunken areas so enlarged as to give the whole a jaundiced appearance coupled with pock markings. The results of observations indicate that the spores of the fungus lodge, germinate, and enter through the stomata or pores of the fruit, and that in some instances development is inhibited while the fruit is actively growing and proceeds unrestrained after the fruit is picked. In this particular case the disease did not run its natural course because the fruit rapidly deteriorated. Normally only one to four diseased areas appear on a fruit, and when they attain a diameter of three-fourths to 1 inch they develop a salmon-pink colored ring near their outer margin. As the areas continue to enlarge the centers become more depressed and dry out, often cracking. The fruit then presents a shrunken mummified appearance and becomes covered with the characteristic salmon-pink spores. More often, however, a wet rot is involved, and the fruit falls to the ground and rapidly decays.

INTERNAL PARASITES OF POULTRY

Studies of internal parasites of poultry were made, but special buildings and equipment are needed to permit carrying the various phases of the work to conclusion. The information gained from the studies so far has, however, been of value in rapid diagnosis and treatment of the poultry troubles.

Internal parasites of chickens seem to be more prevalent during the dry season than during the period of heavy rains which normally lasts from four to six months of the year. Probably the liability to infestation and reinfestation through intermediate hosts is reduced by the mechanical action of the rains in washing the ranges, runs, and yards free from infested droppings. If this is borne out by test it will have an important bearing on methods of control and sanitation.

The kinds of roundworms commonly found in the poultry of the island are the eye worm (*Oxyspirura mansoni* (*Filaria mansoni*) (*Spiroptera emmerezii*)), the esophageal worm (*Capillaria annulata*), the stomach or gizzard worm (*Acuria nasuta*), the intestinal roundworm (*Galli perspicillum* (*G. inflexa*)), and the caecum worm (*Heterakis gallinae*). Tapeworms and coccidia are also present.

The eye worm is slender, transparent, 14 to 18 millimeters long, tapers at both ends, and is found beneath the nictitating membrane and occasionally in the nasal passages. It is the least common of the roundworms, and local infestations are mild. The eye worm seldom shows symptoms of its presence in fowls and can be perceived only by pressure of the thumb nail against the anterior part of the eye. When thus pushed out upon the eyeball, the worm appears as an animated threadlike mucus and then disappears beneath the eyelids. The intermediate host of this worm is reported from Florida to be the cockroach (*Blatta orientalis*). This species is not found in Guam, but examination of *B. americana* and *B. germanica* from premises known to be infested with eye worm failed to reveal the immature stages of the parasite.

The esophageal worm is exceedingly slender and lives imbedded in winding galleries formed in the mucosa of the esophagus and upper portion of the crop. Females 25 millimeters long have been found. When these larger specimens are near the surface their white bodies can be detected against the pinkish mucosa by means of a hand lens. When the worms are deeply buried they can be seen only by transmitting a strong light through a portion of the esophagus placed on a glass slide. The males are slightly shorter and more slender than the females and without high magnification and detailed study can be distinguished from the female only by the absence of ova. The ova are elongate-oval in shape, brownish in color, and have a clear opercular plug at both ends. They are very numerous in the galleries formed in the mucosa and are readily perceived in the feces. Apparently the worms in large numbers may be present without seriously affecting the fowl.

The stomach or gizzard worm is slender, pearly white, and found free or with the head end buried in the stomach lining. The female is 5 to 8 millimeters long, and has a short, stubby tail pointing

slightly to one side. The male is 4 to 6 millimeters long, more slender than the female, and has a pointed tail twice as long and curved into a hook. Both sexes have four recurved wavy oral papillae and eight pairs of very small anal papillae. The ova are minute, round to oval in shape, almost clear to slightly pinkish in color, and very difficult to detect in the feces. The stomach worm was not so commonly found as were some of the other kinds, but according to some authorities, the parasite may cause serious trouble when it is present in large numbers.

The intestinal roundworm is the largest of the roundworms of poultry, mature females being 6 to 10 centimeters long and 2 to 2½ millimeters thick. The color is yellowish white, and the skin is practically opaque. The males are 4 to 8 centimeters long, more slender than the females, and otherwise appear to be exactly like them. The ova are elliptical with hyaline double-walled contour. The contents are granular with inconspicuous central vacuole. Large numbers of the ova are expelled with the feces even when only a few worms are present in a fowl. The ova are easily recognized upon microscopic examination of the feces. The presence of this roundworm in large numbers causes marked emaciation, ruffled plumage, and other symptoms of lack of thrift, especially among half-grown chickens, and is a probable factor in delaying and reducing egg production in pullets. Older stock although infested seem to be more resistant to the effects of the worm. The absorption by the fowl of the poisonous secretion of the worms rather than the presence of the worm itself probably causes the above-mentioned symptoms. These worms, however, when numerous enough may obstruct food passages, an effect which is unusual and results in the death of the fowl.

The caecum worm is small, and brownish white in color. The female is 10 to 12 millimeters long, and 0.5 millimeter thick. It has a slender, pointed tail one-fourth to one-fifth as long as the body. The male is about two-thirds as long as the female and more slender. It has large, rudderlike anal papillae immediately in front of the short, sharp-pointed tail. The ova resemble very closely those of the intestinal roundworm but differ from them in having a less hyaline and refractile double-walled contour and a V-shaped vacuole extending to the side wall. As the name implies, the caecum worm is usually found in the caecum and adjacent intestines. The worm is generally present in fowls, but its exact status as a pest has not been determined because of its association with infestations of coccidia.

Only one kind of tapeworm—a species of the genus *Davainea*—has been found in Guam. *D. echinobothridia* has been reported as present in the past, but certain features of the tapeworms studied by the writer do not coincide with published descriptions of *D. echinobothridia*. For example, the suckers of the scolex are unarmed, the rostellum protrudes little, if any, and the head is larger than the strobila immediately behind it, and there is a definite neck area. This tapeworm is commonly found locally and along with the intestinal roundworm forms the most serious combination of internal parasites of poultry.

Although an absolutely positive identification of coccidia has not as yet been made, apparently coccidiosis is prevalent in chickens

on the island. It does not seem to cause much trouble, however, except in chicks under 8 to 12 weeks of age and is most serious in flocks that are kept closely confined in unsanitary houses and runs.

METEOROLOGICAL OBSERVATIONS, 1928-29

Observations made at the station on temperature, precipitation, and wind are summarized in Table 2.

TABLE 2.—*Condensed meteorological data for the year ended June 30, 1929*

Month	Temperature					Total precipitation	Prevailing wind direction
	Maximum	Minimum	Mean maximum	Mean minimum	Monthly mean		
1928	°F.	°F.	°F.	°F.	°F.	Inches	
July.....	87.5	73.5	84.55	76.50	80.52	16.41	Northeast.
August.....	88.0	74.0	85.39	76.28	80.83	11.00	West.
September.....	88.0	70.0	84.50	75.66	80.08	16.78	Do.
October.....	88.0	73.5	85.12	76.15	80.63	18.62	Northeast.
November.....	89.0	73.0	86.74	76.15	81.44	7.27	Do.
December.....	88.5	72.5	85.64	76.08	80.86	8.14	East.
1929							
January.....	87.5	68.0	84.50	74.43	79.46	2.66	Northeast.
February.....	88.5	72.0	85.03	73.98	79.50	2.60	Do.
March.....	87.5	72.5	85.24	74.75	79.99	4.41	East.
April.....	88.5	73.0	86.60	76.00	81.30	2.29	Northeast.
May.....	89.0	73.5	86.94	76.66	81.80	6.27	East.
June.....	88.0	73.0	86.29	75.38	80.83	6.33	Southeast.
Total.....						102.78	

